KEITHLEY

Model 130
Digital Multimeter
Operator's Manual

MP MASTER
MA28566

Specifications

DC VOLTAGE

RANGE	RESOLUTION	ACCURACY (1 YEAR) 18° to 28°C
200mV	100μV	
2 V	1mV	
20 V	10mV	±(0.5% of reading + 1 d)
200 V	100mV	
1000 V	1 V	

MAXIMUM ALLOWABLE INPUT: 1000V DC or peak AC non-switched, 750V peak switched
INPUT RESISTANCE: 10MΩ
NORMAL MODE REJECTION RATIO: Greater than 46dB at 50Hz, 60Hz
COMMON MODE REJECTION RATIO: Greater than 100dB at DC, 50Hz and 60Hz (1kΩ unbalance)

AC VOLTAGE

RANGE	RESOLUTION	ACCURACY (1 YR) 18° to 28°C	FREQUENCY RANGE
200mV	100μV		45Hz—500Hz
2 V	1mV		45Hz—500Hz
20 V	10mV	±(1% of rdg + 5d)	45Hz—500Hz
200 V	100mV		45Hz—120Hz
750 V	1 V		45Hz—120Hz

MAXIMUM ALLOWABLE INPUT: 1000V peak non-switched, 750V peak switched; continuous except 200mV range: 15 sec max above 300V
INPUT IMPEDANCE: 10MΩ shunted by less than 100pF
RESPONSE: Average responding, calibrated in rms of a sine wave

DC CURRENT

RANGE	RESOLUTION	ACCURACY (1 YR) 18° to 28°C	MAXIMUM FULL SCALE VOLTAGE BURDEN
2mA	1μA	±(1% rdg + 1d)	0.25V
20mA	10μA	±(1% rdg + 1d)	0.25V
200mA	100μA	±(1% rdg + 1d)	0.25V
2000mA	1mA	±(2% rdg + 1d)	0.7 V
10 A	10mA	±(2% rdg + 1d)	0.3 V

OVERLOAD PROTECTION: mA input: 2A fuse (250V), externally accessible; 10A input: 20A for 15 sec unfused

AC CURRENT

RANGE	RESOLUTION	ACCURACY (1 YR) 18° to 28°C (45Hz—500Hz)	MAXIMUM FULL SCALE VOLTAGE BURDEN
2mA	1μA	±(2% rdg + 5d)	0.25V rms
20mA	10μA	±(2% rdg + 5d)	0.25V rms
200mA	100μA	±(2% rdg + 5d)	0.25V rms
2000mA	1mA	±(3% rdg + 5d)	0.7 V rms
10 A	10mA	±(3% rdg + 5d)	0.3 V rms

OVERLOAD PROTECTION: mA input: 2A fuse (250V), externally accessible; 10A input: 20A for 15 sec unfused

RESISTANCE

RANGE	RESOLUTION	ACCURACY (1 YR) 18° to 28°C	FULL SCALE VOLTAGE
200 Ω	100mΩ	±(0.5% rdg + 4d)	<0.5V
2kΩ	1 Ω	±(0.5% rdg + 1d)	<0.5V
20kΩ	10 Ω	±(0.5% rdg + 1d)	>0.7V
200kΩ	100 Ω	±(0.5% rdg + 1d)	>0.7V
20MΩ	10kΩ	±(2% rdg + 1d)	>0.7V

MAXIMUM OPEN CIRCUIT VOLTAGE: 1.5V
MAXIMUM ALLOWABLE INPUT: 300V DC or rms

GENERAL

DISPLAY: 3½-digit LCD, 0.6" height, with polarity and range indication.
OVERRANGE INDICATION: 3 least significant digits blanked
MAXIMUM COMMON MODE VOLTAGE: 500V peak
OPERATING ENVIRONMENT: 0° to 50°C; less than 80% relative humidity up to 35°C, less than 70% relative humidity from 35°C to 50°C
STORAGE ENVIRONMENT: −35°C to 60°C
TEMPERATURE COEFFICIENT (0° to 18°C and 28° to 50°): Less than 0.1 × applicable accuracy specification per °C
POWER: 9V alkaline or carbon-zinc battery (NEDA 1604)
BATTERY LIFE: 100 hours typical with carbon-zinc cells, 200 hours with alkaline cells
BATTERY INDICATOR: Display indicates BAT when less than 10% of life remains
DIMENSIONS, WEIGHT: 178mm long × 78mm wide × 38mm thick (7.1" × 3.1" × 1.5"). Net weight 283g (10 oz.).

ACCESSORIES AVAILABLE:

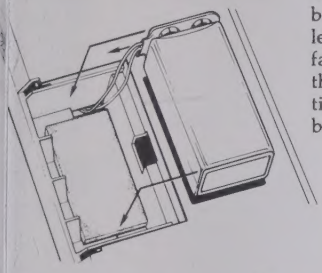
- Model 1304 Soft Carrying Case and Stand
- Model 1309 Spare Parts Kit
- Model 1600 High Voltage Probe
- Model 1651 50-Ampere Shunt
- Model 1681 Clip-On Test Lead Set
- Model 1682 RF Probe
- Model 1683 Universal Test Lead Kit
- Model 1685 Clamp-On Current Probe
- Model 1691 General Purpose Test Lead Set

Model 130 with Batteries and Test Leads

Specifications subject to change without notice.

Battery Installation/Replacement

A 9V battery is supplied with the instrument but not installed. To install or replace the battery, remove the cover from the battery compartment by sliding it off in the direction of the arrow located on the battery cover. The battery connector snaps on and off the terminal of the battery. Improper installation of the battery will cause the connecting wires to be severed by excess strain. Proper installation requires that the battery be positioned in such a manner (see drawing) that the leads protruding from the boot of the battery connector face toward the out-side of the battery compartment. If the instrument is going to be stored for a long period of time or in a high temperature environment, remove the battery to prevent leakage damage.



Fuse Check

With the instrument set to the 2kΩ range, connect a jumper from the V-Ω jack to the mA jack. The display should read approximately .100. An overranged display would typically indicate a blown fuse. A display reading other than approximately .100 could indicate a defective current input circuit (see schematic).

Fuse Replacement

A 2-amp fuse protects the 2mA through 2000mA current ranges. To gain access to the fuse, remove the fuse compartment cover in the same manner as removing the battery compartment cover. Remove the fuse by pulling outward on the plastic tab that encircles the fuse body. Install the plastic tab on the new fuse and snap the fuse back into the fuse holder. Do not replace the fuse with a higher rated value or instrument damage that is not covered by the warranty may occur.

Diode Test

The 20 kΩ range can be used for testing of semiconductor junctions. A junction is probably good if the 130 indicates an overrange reading when the semiconductor is reversed biased, and an on-range reading, when the semiconductor is forward biased. (The V-Ω jack is positive).

WARNING

All service information is intended for qualified electronic maintenance personnel only.

Calibration Procedure

EQUIPMENT NEEDED: +190mVDC voltage source with .05% accuracy or better.

MODEL 130 SETTINGS: DCV function, 200mV range, V-Ω and COM input jacks.

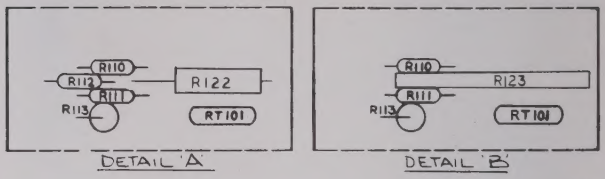
ENVIRONMENTAL CONDITIONS: Ambient temperature of 25° ± 3°C (77° ±5°F); relative humidity less than 80%

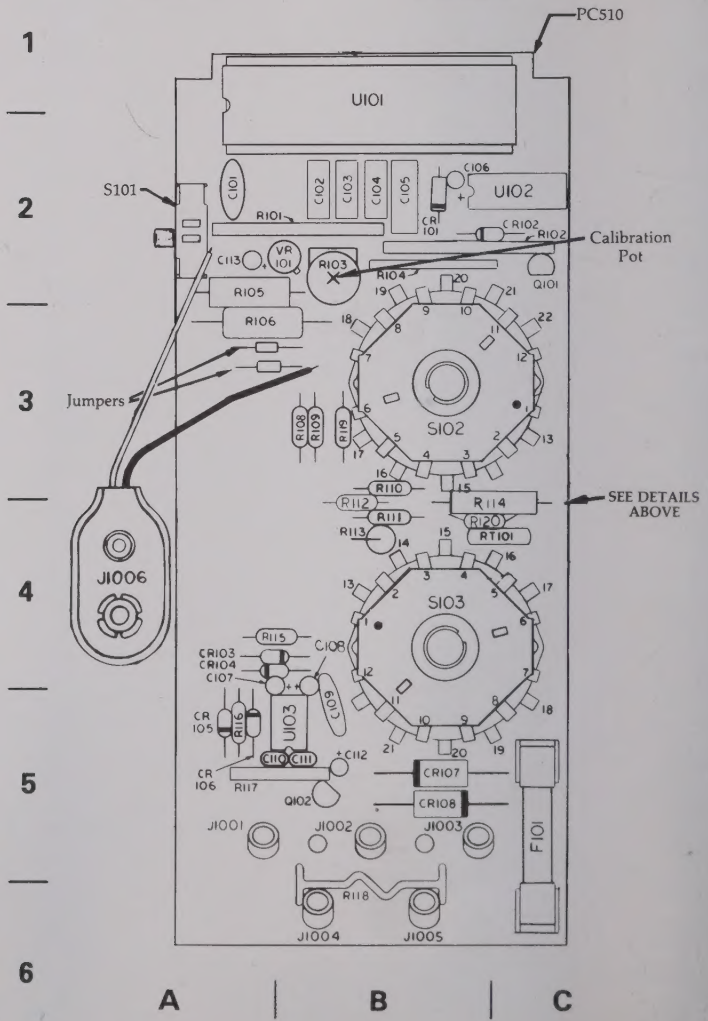
PROCEDURE:

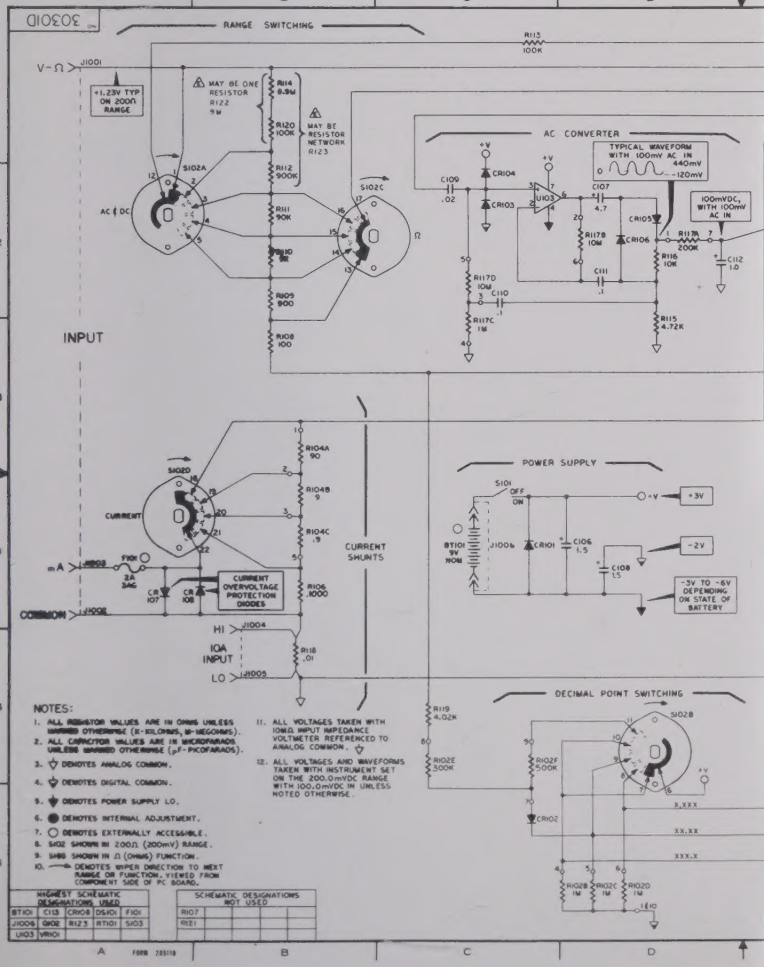
Remove the bottom cover as explained in the Disassembly Instructions to gain access to the calibration pot (R103). Apply the +190mV to the Model 130 input and adjust R103 for a display reading of 190.0 ±1 digit. This is the only adjustment needed to calibrate the instrument. Calibration should be performed yearly.

Component Layout

ALTERNATE CONFIGURATIONS






RANGE SWITCHING
AC CONVERTER
POWER SUPPLY
DECIMAL POINT SWITCHING
INPUT
CURRENT SHUNTS
V-Ω
mA
COMMON
HI
LO
10A INPUT
+1.23V TYP ON 200Ω RANGE
MAY BE ONE RESISTOR R122 9W
MAY BE RESISTOR NETWORK R123
TYPICAL WAVEFORM WITH 100mV AC IN
440mV
-120mV
100mVDC, WITH 100mV AC IN
CURRENT OVERVOLTAGE PROTECTION DIODES
OFF ON
+3V
-2V
-3V TO -6V DEPENDING ON STATE OF BATTERY
9V NOM
NOTES:
1. ALL RESISTOR VALUES ARE IN OHMS UNLESS MARKED OTHERWISE (K-KILOHMS, M-MEGOHMS).
2. ALL CAPACITOR VALUES ARE IN MICROFARADS UNLESS MARKED OTHERWISE (pF-PICOFARADS).
3. ▽ DENOTES ANALOG COMMON.
4. ⏚ DENOTES DIGITAL COMMON.
9. ⏚ DENOTES POWER SUPPLY LO.
6. ● DENOTES INTERNAL ADJUSTMENT.
7. ○ DENOTES EXTERNALLY ACCESSIBLE.
8. S102 SHOWN IN 200Ω (200mV) RANGE.
9. S103 SHOWN IN Ω (OHMS) FUNCTION.
10. → DENOTES WIPER DIRECTION TO NEXT RANGE OR FUNCTION, VIEWED FROM COMPONENT SIDE OF PC BOARD.
11. ALL VOLTAGES TAKEN WITH 10MΩ INPUT IMPEDANCE VOLTMETER REFERENCED TO ANALOG COMMON. ▽
12. ALL VOLTAGES AND WAVEFORMS TAKEN WITH INSTRUMENT SET ON THE 200.0mVDC RANGE WITH 100.0mVDC IN UNLESS NOTED OTHERWISE.
HIGHEST SCHEMATIC DESIGNATIONS USED
BT101 C113 CR108 DS101 F101
J1006 Q102 R123 RT101 S103
U103 VR101
SCHEMATIC DESIGNATIONS NOT USED
R107 R121

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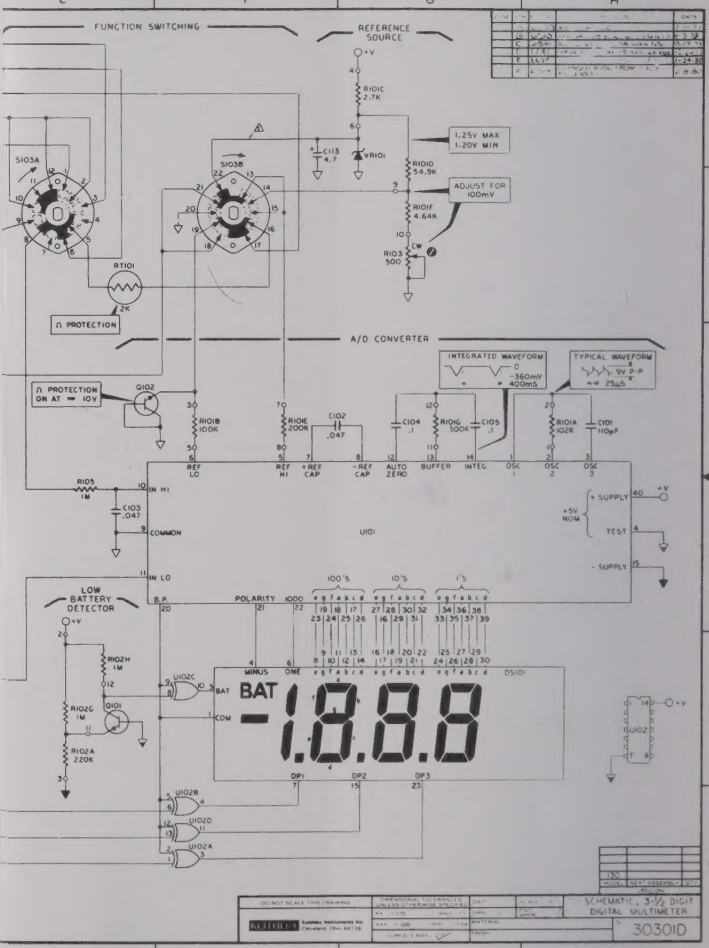

FUNCTION SWITCHING
REFERENCE SOURCE
A/D CONVERTER
1.25V MAX
1.20V MIN
ADJUST FOR 100mV
Ω PROTECTION
Ω PROTECTION ON AT ⇒ 10V
INTEGRATED WAVEFORM
TYPICAL WAVEFORM
LOW BATTERY DETECTOR
SCHEMATIC, 3-½ DIGIT DIGITAL VOLTMETER
30301D

Parts List

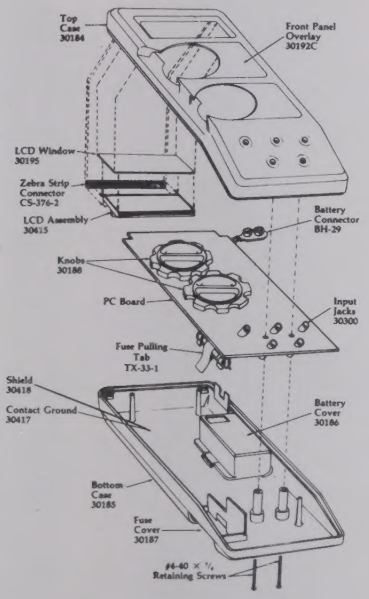
Circuit Design	Description	Schematic Location	PC Board Location	Keithley Part No.
BT101	Battery, 9V, NEDA 1604	C4	—	BA-14
C101	Cap, 110pF, 500V, Mica	H3	A2	C-278-110P
C102	Cap, .047μF, 100V, Polyester	F3	B2	C-305-.047
C103	Cap, .047μF, 100V, Polyester	E4	B2	C-305-.047
C104	Cap, .1μF, 100V, Polyester	G3	B2	C-305-.1
C105	Cap, .1μF, 160V, Polypropylene	G3	B2	C-306-.1
C106	Cap, 1.5μF, 20V, Tantalum	D4	B2	C-179-1.5
C107	Cap, 4.7μF, 20V, Tantalum	D2	A4	C-179-4.7
C108	Cap, 1.5μF, 20V, Tantalum	D4	B4	C-179-1.5
C109	Cap, .02μF, 1000V, Ceramic Disc	C2	B5	C-316-.02
C110	Cap, .1μF, 50V, Ceramic	C2	A5	C-237-.1
C111	Cap, .1μF, 50V, Ceramic	D2	B5	C-237-.1
C112	Cap, 1μF, 20V, Tantalum	D2	B5	C-179-1
C113	Cap, 4.7μF, 20V, Tantalum	F1	A2	C-179-4.7
CR101	Rectifier, 1A, 800V	C4	B2	RF-38
CR102	Rectifier, 75mA, 75V	C6	C2	RF-28
CR103	Rectifier, 75mA, 75V	C2	A4	RF-28
CR104	Rectifier, 75mA, 75V	C2	A4	RF-28
CR105	Rectifier, 75mA, 75V	D2	A5	RF-28
CR106	Rectifier, 75mA, 75V	D2	A5	RF-28
CR107	Rectifier, 3A, 50V	A4	B5	RF-34
CR108	Rectifier, 3A, 50V	B4	B5	RF-34
DS101	Liquid Crystal Display Assembly	G5	—	30415
	Zebra Connector Strip	—	—	CS-376-2
F101	Fuse, 2A, 250V, 3AG, USA Models	A4	C5	FU-13
F101	Fuse, 2A, 250V, 5 × 20mm, European Models	A4	C5	FU-48
J1001	Jack, Input	A1	A5	30300
J1002	Jack, Input	A4	B5	30300
J1003	Jack, Input	A4	B5	30300
J1004	Jack, Input	B5	B6	30300
J1005	Jack, Input	B5	B6	30300
J1006	Connector, Battery	C4	A4	BH-29
Q101	Transistor, NPN, Switch, 2N3904	E5	C2	TG-47
Q102	Transistor, NPN, Silicon, GES5818	E3	B5	TG-138
R101	Thick Film Resistor Network	Several	A2	TF-97
R102	Thick Film Resistor Network	Several	C2	TF-95
R103	Pot, 500Ω	G2	B2	RP-119-500
R104	Thick Film Resistor Network	B3, B4	B2	TF-94
R105	Resistor, 1MΩ, 10%, 1W, Comp	E4	A2	R-2-1M
R106	Resistor, .1Ω, .5%, 1W, WW	B4	A3	R-279-.1
R107	NOT USED			
R108	Resistor, 100Ω, .1%, 1/10W, MtF	B3	B3	R-283-100
R109	Resistor, 900Ω, .1%, 1/10W, MtF	B2	B3	R-283-900
R110	Resistor, 9kΩ, .1%, 1/10W, MtF	B2	B3	R-283-9k
R111	Resistor, 90kΩ, .1%, 1/10W, MtF	B2	B4	R-283-90k
R112	Resistor, 900kΩ, .1%, 1/10W, MtF	B2	B4	R-283-900k
R113	Resistor, 100kΩ, 10%, 1W, Comp	C1	B4	R-2-100k
R114	Resistor, 8.9MΩ, .1%, 1W, CerF	B1	C4	R-281-8.9M
R115	Resistor, 4.72kΩ, .1%, 1/10W, MtF	D3	A4	R-283-4.72k
R116	Resistor, 10kΩ, .1%, 1/10W, MtF	D2	A5	R-283-10k
R117	Thick Film Resistor Network	Several	A5	TF-96
R118	Resistor, 0.01Ω, 0.5%, 1W, WW	B5	B6	R-280-.01
R119	Resistor, 4.02kΩ, 1%, 1/8W, MtF	C5	B3	R-88-4.02k
R120	Resistor, 100kΩ, .1%, 1/10W, MtF	B1	C3	R-283-100k
R122	Resistor, 9MΩ, .08%, 2W	B1	C4	R-277-9M
R123	Thick Film Resistor Network	B1	C4	TF-104
RT101	Thermistor, 8mA, 500V, PTC	E2	C4	RT-6
S101	Switch, SPDT, ON-OFF	C4	A2	SW-417
S102	Switch, Rotary, Range	Several	B3	SW-418
S103	Switch, Rotary, Function	E2, F2	B4	SW-419
U101	3½-Digit Single Chip A/D Converter	G4	B1	~~LSI-22~~ 1277
U102	CMOS Quad Exclusive OR Gate	F5, F6	C2	30810
U103	Low-Power JFet-Input OP-Amp	C2	B5	IC-227
VR101	Diode, Low Voltage Reference	G1	B2	DZ-62

Disassembly Instructions

Place the unit face down on a bench or other similar surface and remove the battery compartment cover. Disconnect and remove the battery. Remove the two #4-40 × $^{7}/_{8}$ retaining screws.

Grasp the bottom cover at the input jack end and with a lifting and forward pushing motion (see drawing), carefully remove the bottom cover. While removing the cover, feed the battery connector through the access hole in the bottom of the battery compartment.

The component side of the PC board is now exposed and the battery can be reconnected for troubleshooting and calibration. To read the display, some light downward pressure at the top end of the circuit board may be required in order to make contact, through the elastomer (zebra) contact strip, between the circuit board and the LCD.



The PC board and LCD assembly are not secured once the case retaining screws are removed. Be careful not to allow the PC board and LCD assembly to fall out or shift out of position during calibration.

To remove the PC board from the top cover, grasp the function switch assembly and lift until the input jacks become disengaged from the cover. The PC board can now be removed using a slight clockwise motion to free the two switch knobs from their normal positions in the case.

The LCD assembly will remain in the top cover when the PC board is removed. Again, be careful not to allow the LCD assembly to fall out accidentally.

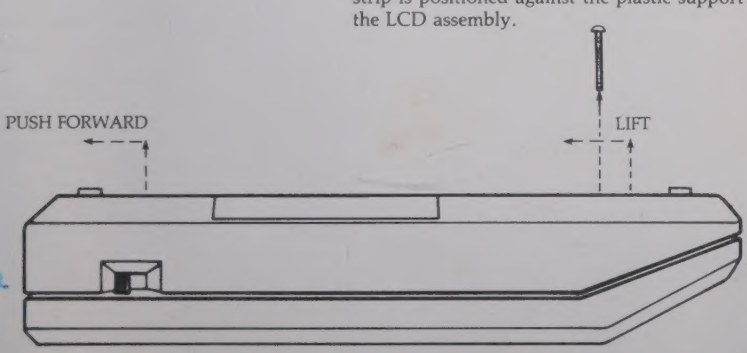
The two switch knobs can be removed from the PC board assembly by simply pulling them off the switch shafts.

The LCD assembly, along with the zebra strip connector, lifts out of the case.

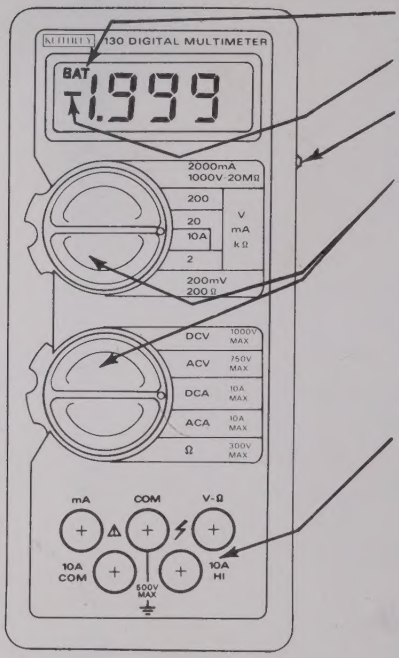
To reassemble the Model 130, remove the cover on the fuse compartment and reverse the above procedures.

Note

Proper alignment of the zebra strip connector is necessary when reinstalling the LCD assembly. Make sure that the conductor side of the zebra strip is positioned against the plastic support of the LCD assembly.



Operating Instructions



Low Battery Indicator

Minus sign displayed
Plus sign implied

1. **SET POWER ON** (slide switch located on side of instrument).

2. **SELECT FUNCTION AND RANGE**
   DCV—200mV, 2V, 20V, 200V or 1000V
   ACV—200mV, 2V, 20V, 200V or 1000V
   NOTE: 750VAC is maximum allowable AC input.
   DCA—2mA, 20mA, 200mA, 2000mA or 10A
   ACA—2mA, 20mA, 200mA, 2000mA or 10A
   Ω—200Ω, 2kΩ, 20kΩ, 200kΩ or 20MΩ

3. **INPUT**—Select appropriate pair of input jacks.
   COM, V-Ω—for all voltage and resistance measurements.
   COM, mA—for current measurements up to 2000mA.
   *10A COM, 10A HI - for current measurements up to 10A.
   *These input jacks may be labled LO 10A, and HI 10A on some units.

An overranged condition is indicated by a "1" followed by a blank display.

⚠ CAUTION

Do not, under any circumstances, use the 10A COM or 10A HI imput jacks with the COM input jack for making measurements. This is a short and will damage the instrument.

SAFETY PRECAUTIONS

1. Do not exceed the instrument's maximum allowable inputs as defined in the Specifications.
2. Do not apply more than 500V peak above earth ground to the COM input jack.
3. Turn the 130 off and disconnect test leads before replacing the battery or fuse. Put the covers back into place on the compartments before resuming use of the instrument.
4. Exercise extreme caution when a shock hazard is present at its input. The American National Standard Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30 volts rms or 42.4 volts peak are present.
5. A good safety practice is to expect that hazardous voltages are present in any unknown circuit to be measured, until actual conditions are verified.

The battery and fuse are accessible from the bottom of the instrument. Note the precautions on the case before installing or replacing either.

SERVICE POLICY

For service on your Model 130 DMM, contact your local representative who will be able to give you immediate assistance in most cases. Complete repair and calibration facilities are maintained in Cleveland, Ohio; Munich, West Germany; and Reading, United Kingdom, as well as first line repair service in Palaiseau, France. Information concerning the application, operation or service of your instrument may be directed to the applications engineer at any of the above locations.

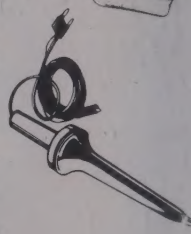
WARRANTY

We warrant each of our products to be free from defects in material and workmanship. Our obligation under this warranty is to repair or replace, at our option, any instrument or part thereof which, within a year from date of shipment, proves defective upon examination. We will pay local domestic surface freight costs. (NOTE: This warranty does not cover battery replacement or damage due to battery leakage.)

Accessories

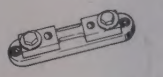
MODEL 1304 SOFT CARRYING CASE AND STAND for the Model 130; also includes a condensed operator's instruction card.

MODEL 1309 SPARE PARTS KIT is a collection of specially selected parts to maintain up to ten Model 130 DMMs for one year.

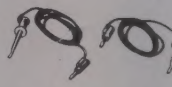


MODEL 1600 HIGH VOLTAGE PROBE extends the DMM to 40kV. It has a 1000:1 division ratio, which means that 1 volt on the DMM corresponds to 1 kilovolt.
TO OPERATE: Set the DMM to DCV and appropriate range. Connect the banana plug on the Model 1600 to the input jacks. Connect the alligator clip on the Model 1600 to source LO. Connect the probe tip to source HI.

SPECIFICATIONS, MODEL 1600
VOLTAGE RANGE: 0 to 40,000VDC.
INPUT RESISTANCE: 1000 MΩ.
DIVISION RATIO: 1000:1.
RATIO ACCURACY:
±1.5% at 25kV, decreasing to
±2.0% at 20kV and 30kV
±3.0% at 10kV and 40kV, and
±4.0% at 1kV.
RATIO STABILITY: ±0.01%/°C, ±0.1%/year
HEATING EFFECTS: Self-heating due to application of high voltage for period in excess of 1 minute will cause a maximum of 0.2% additional error at 40kV (error is less at lower voltage).



MODEL 1651 50-AMPERE SHUNT allows current measurements to be made up to 50-amperes. It is a 0.001 ohm ±1% 4-terminal shunt. When the DMM is set to the 2 volt range, a 50-ampere current will correspond to 50 millivolts (.0500 volts).
TO OPERATE: Connect separate current leads (not furnished) between the source and the Model 1651 hex-head bolts. Use leads that are rated up to 50-ampere capacity. Connect the voltage leads (furnished) between the Model 1651 screw terminals and the DMM input jacks. Set the DMM to ACV or DCV and 200mV range.



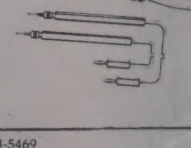
MODEL 1681 CLIP-ON TEST LEAD SET contains two leads, 1.2m (48 inches) long, terminated with banana plug and spring action clip-on probe.

MODEL 1682 RF PROBE allows voltage measurements from 100kHz to 100MHz with the Model 130.

TO OPERATE: Set the DMM to DCV and appropriate range. Connect the Model 1682 to the DMM input jacks.
SPECIFICATIONS, MODEL 1682
VOLTAGE RANGE: 0.25 to 30V rms.
TRANSFER ACCURACY: ±0.5dB, 100kHz to 1000MHz peak responding calibrated in rms of a sine wave.
INPUT IMPEDANCE: 4MΩ shunted by 3pF.
MAXIMUM ALLOWABLE INPUT: 30V rms AC, 200V DC.
ACCESSORIES SUPPLIED: Straight tip, hook tip, ground clip, HI adapter, banana plug adapter.

MODEL 1683 UNIVERSAL TEST LEAD KIT consists of two test leads, 1.2m (48 inches) long with 12 screw-in tips—2 banana plugs, 2 spade lugs, 2 alligator clips with boots, 2 needle tips with chucks and 4 heavy-duty tip plugs.

MODEL 1685 CLAMP-ON AC CURRENT PROBE measures AC current by clamping onto asingle conductor. Interruption of the current path is unnecessary. The Model 1685detects current by sensing magnetic field produced by current.
TO OPERATE: Set the DMM to ACV and appropriate range. Connect the Model 1685 to the DMM input jacks. The DMM will display 0.1V rms per ampere.
Specifications, Model 1685
RANGE: 2, 20 and 200 amperes rms.
ACCURACY: ±4% of range at 60Hz, ±6% of range at 50Hz.
TEMPERATURE COEFFICIENT: ±0.05%/°C on the 20 and 200 ampere ranges. ±0.3%/°C on the 2 ampere range.
MAXIMUM ALLOWABLE CURRENT: 300 amperes rms.
MAXIMUM CONDUCTOR VOLTAGE: 600 volts rms.
CONVERSION RATIO: 0.1V rms per ampere.



MODEL 1691 GENERAL PURPOSE TEST LEAD SET consists of two .91m (36 inches) test leads with probe tips terminated in banana plugs.

KEITHLEY

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